

DIGITALISATION AND ECONOMIC GROWTH: AN ANALYSIS OF SELECTED ASEAN COUNTRIES

AHMAD SYAMIM IZZHAR AHMAD RADHI, MASTURAH MA'IN*, NURUL SYIFAA MOHD SHAKIL AND ISMAH OSMAN

Faculty of Business and Management, Universiti Teknologi MARA, Puncak Alam Campus, Selangor Branch, 42300 Puncak Alam, Selangor, Malaysia.

*Corresponding author: maszan@uitm.edu.my

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Abstract: The digitalisation of the global economy and digital technologies promote trade expansion and cross-border commerce. However, ASEAN countries lack a strategic vision due to weak leadership. This study examines the effects of digitalisation and macroeconomic factors such as inflation, trade openness, and unemployment on the economic growth of seven ASEAN countries from 2002 to 2021. Using data on gross domestic product, mobile cellular subscription, trade openness, inflation, and unemployment rates, this study employed static panel data analysis, including panel specification tests and diagnostic tests. The findings revealed an association between digitalisation, unemployment, trade openness, and economic growth in the seven ASEAN countries. The governments of these countries should direct their attention towards policies that will accelerate the advancement of digital technologies and increase employment, as both have been demonstrated to have a positive impact on economic growth. Adoption of digital technologies and the digitalisation of the global economy offer governments across the globe significant advantages, including enhanced efficacy, transparency, and responsiveness while reducing corruption and bureaucratic obstacles.

Keywords: Digitalisation, ASEAN, economic growth, macroeconomic factors.

Introduction

Technology is defined as the application of scientific knowledge from discoveries and experiments to practical aims in everyday human life, thereby transforming and enhancing the human environment (Britannica, 2022). Numerous inventions and scientific methods have assisted societies worldwide in their daily activities. Many inventors and researchers have dedicated their lives to produce technology that improves productivity in everyday tasks. According to Hecht (2018), almost every industry has made significant progress in production and productivity due to technological advancements such as in the automobile and aircraft industries. Furthermore, endogenous growth theory posits that the Internet contributed to economic growth by facilitating the creation of new innovation processes for businesses (Kurniawati, 2020). This theory emphasises several options for expansion in both physical capital and knowledge.

Technology has been utilised to enhance output process performance, making it more effective and efficient. According to Digital Adoption (2022), technological applications used in industries such as communication, office productivity, research, data security, and analytics have supported organisations professionally in their operations through software packages and technology systems. Additionally, information technology has been designed to support activities related to operating system, applications, source code, data, and hardware of information within organisations (Amini & Jahanbakhsh Javid, 2023). Other technological applications include quantum technology, which has been designed to improve digital communication through devices such as lasers, magnetic resonance imaging scanners and atomic clocks (Khondakar, 2024), and 5G technology, which enhances the speed and efficiency of network connectivity.

Kurniawati (2020) agreed that Information and Communication Technologies (ICT) have played a significant role in shaping social and economic development. Entities such as individuals, businesses, and governments benefit from technological advancements such as digitalisation processes, in their day-to-day operations. The digitalisation of the global economy with the aid of digital technologies, which is to promote trade expansion and cross-border commerce can be beneficial for organisational productivity (Edunjobi, 2024).

Despite the goal of playing a central role in economic integration and creating the world's largest free trade agreements, ASEAN still lacks strategic vision and priorities due to weak leadership among its members (Stern *et al.*, 2022). The projected Internet economy value from 2019 to 2025 for six ASEAN countries shows Indonesia leading with an expected value of US\$133 billion in 2025, followed by Thailand (US\$50 billion), Vietnam (US\$43 billion), Singapore (US\$27 billion), Malaysia (US\$26 billion), and the Philippines (US\$25 billion) (von Kameke, 2023). The growth of the Internet economy in these countries is driven by e-commerce, as customers increasingly turn to online shopping even after the COVID-19 pandemic (Medina, 2020).

Kearney (2022) provided a clear picture of the current digital economy performance of ASEAN countries, showing that while Malaysia and Singapore outperformed in all three elements—device, network, and application—countries such as Thailand, the Philippines, Indonesia, Vietnam, Cambodia, and Myanmar were rated from underperforming to satisfactory. According to ASEAN (2022), advancing economic growth, social progress, and cultural development in the region could be achieved through joint efforts to strengthen the foundation for a peaceful ASEAN community. Additionally, member countries have taken steps to adopt the latest advanced technology to stabilise and enhance economic growth (Asghar *et al.*, 2023).

Since the beginning of this decade, economic growth has struggled to meet expectations due to transformative changes, particularly in technological development and digital transformation (Qureshi & Ordu, 2020). The Gross Domestic Product (GDP) growth rate reflects changes in the size of an economy over time by measuring the fluctuations in the production of goods and services (Callen, 2022) while also accounting for technology and macroeconomic factors that influence GDP growth (Alabed *et al.*, 2021).

Table 1 shows the trend and prediction of GDP growth rates from 2019 to 2023 among Southeast Asia countries (Asian Development Bank, 2022). The average GDP growth rate decreased from 2019 to 2020 with Cambodia, Indonesia, Lao PDR, Malaysia, the Philippines, Singapore, and Thailand showing declines. This downturn was likely due to the impact of the COVID-19 pandemic and lockdowns, which stunted economic activity. However, Brunei Darussalam, Vietnam, and Myanmar recorded a slight increase during the same period. In 2021, the recovery saw increased growth among most Southeast Asia countries except for Brunei Darussalam and Myanmar. The Asian Development Bank (2022) projected improvements in GDP growth rates across Southeast Asia from 2021 to 2023. Overall, the trends in Table 1 indicate a mixed trajectory of economic growth as measured by GDP growth rates, among ASEAN countries leading up to 2023.

Several studies have examined the effect of digitalisation on economic growth, including Georgescu *et al.* (2021) in European state countries, Wang *et al.* (2022) in China, Nayak and Sahoo (2021) in India, Kurniawati (2020) in Organisation for Economic Cooperation and Development (OECD) countries, and Omar (2019) in the Middle East and North Africa countries.

However, these studies mainly focused on countries from different regions and did not encompass the latest time frame during the

Table 1: Gross Domestic Product (GDP) growth rate (% per year)

Country	2019	2020	2021	2022	2023 **
Southeast Asia	4.7	-3.2	2.9	4.9	5.2
Brunei Darussalam	3.9	1.1	-1.5	4.2	3.6
Cambodia	7.1	-3.1	3.0	5.3	6.5
Indonesia	5.0	-2.1	3.7	5.0	5.2
Lao PDR	4.7	-0.5	2.3	3.4	3.7
Malaysia	4.4	-5.6	3.1	6.0	5.4
Myanmar	6.8	3.2	-18.4	-0.3	2.6
The Philippines	6.1	-9.6	5.6	6.0	6.3
Singapore	1.1	-4.1	7.6	4.3	3.2
Thailand	2.2	-6.2	1.6	3.0	4.5
Vietnam	7.0	2.9	2.6	6.5	6.7

Note: **Prediction

Source: Asian Development Bank (2022)

COVID-19 pandemic. Therefore, this study aims to address this gap by investigating the effect of digitalisation on economic growth in ASEAN countries and examining the influence of macroeconomic factors on economic development in the region, particularly regarding digitalisation, using the most recent data available.

The literature review section will discuss endogenous growth theory as reviewed in previous studies. The sample and theoretical model will be detailed in the methodology section. The data analysis section will present the results and findings of this research. The conclusion and recommendation section will focus on the study's conclusion, recommendations, and policy implications.

Literature Review

Endogenous Growth Theory

Digitalisation and ICT are technological advances that contribute to economic expansion. In recent years, ICT has become increasingly important, playing a significant role not only in the acceleration of globalisation and economic growth but also in the transnationalisation of communications and businesses (Kurniawati,

2022). Contemporary ideas on endogenous growth theory suggest that the Internet contributed to amplification of economic growth by facilitating the design and implement of new innovation processes for businesses (Kurniawati, 2020). This theory emphasises various avenues for growth in both physical capital and knowledge. Aghion and Howitt (1997) argued that the factors influencing the production and investment in technological knowledge are primary determinants of long-term economic growth, especially when these factors are considered internal to the economic system.

One of the objectives of endogenous economic growth is to understand the interaction between technological know-how and various aspects of the economy and society, as well as how this dynamic interplay contributes to economic expansion (Singh & Siddiqui, 2021). However, Omar (2019) argued that long-term growth assumed to be endogenously determined by technical change, resulted from advancements in Research and Development (R&D) within the private sector. This progress generates knowledge that mitigates the diminishing returns to scale associated with capital use in developed models of endogenous growth.

Therefore, from the perspective of the endogenous growth model, it is feasible to incorporate new factors such as public capital and alongside conventional variables like physical and labour capital (Galindo-Martín *et al.*, 2019). Theoretical and empirical evidence from the ideology and model developed by Schumpeter (1934) also supports the argument that technological progress and innovation play essential roles in contemporary growth (Kale & Rath, 2018). The current state of the variables in Malaysia can be seen in the strong positioning of digital technology and high-tech manufacturing in 2023 (Juwai IQI, 2023).

Gross Domestic Product (GDP)

According to the World Bank Group (2021), evaluating economic indicators such as GDP, the unemployment rate, and inflation rate is an effective method to understand the current economic situation and its impact on population. Kale and Rath (2018) described economic growth as a steady process and a progressive system driven by dynamic changes, interactions, and creative ideas of new economic catalysts. Georgescu *et al.* (2021) found that through canonical correlation analysis, a 70.33% variation between a set of digitalisation variables and a set of economic growth variables with a correlation of 0.800. Their regression analysis showed that real GDP growth was primarily influenced by the proportion of enterprises engaging in e-commerce. Similarly, Zhang (2021) found a strong positive correlation between GDP growth as the dependent variable and the growth rate of broadband penetration in China in 2020. This was attributed to broadband Internet access, which played a crucial role in supporting human capital productivity during the COVID-19 pandemic.

There is compelling evidence that ICT infrastructure, innovation, and globalisation influence long-term per capita economic short-term estimates also indicate bidirectional and unidirectional relationships among variables based on ICT indicators, innovation, and globalisation measures. In OECD countries,

these factors promote both short- and long-term economic growth (Portillo *et al.*, 2020). However, ASEAN countries face challenges due to significant gaps in digital connectivity, as these economies still lag behind regional and global benchmarks for Internet usage, affected e-commerce and related product services.

Information and Communication Technology (ICT) and Gross Domestic Product (GDP)

As the availability of new technology increases, economic growth tends to improve and as digitalisation is part of this new technology, it assists in improving economic performance. Elmassah and Hassanein (2021) noted that the adoption of digital technologies by businesses and societies facilitates connections among individuals, organisations, and objects ultimately enhancing life satisfaction. Solomon and Klyton (2020) examined both traditional and non-traditional neoclassical perspectives of ICT, highlighting that ICT can bolster economic growth through capital deepening—primarily driven by decreasing prices for ICT investments—and by stimulating innovation through increasing business-to-business transactions, production spillovers, and network externalities.

Mokyr (2018) suggested that technology lacks a clear distinction the roles of ICT and digitalisation have towards the growth of economy. Elhini and Mourad (2021) noted that countries in the Asia-Pacific region experienced significant economic growth over the past 30 years, transforming from an agriculture-dependent, low-income region to predominant manufacturing hubs, and exporters worldwide with these changes serving as the driving force behind the region's development. Habibi and Zabardast (2020) discovered a unidirectional relationship among mobile users, Internet users, and economic growth along with R&D. However, Zhang (2021) emphasised the significant roles of broadband and Internet, which are heavily embedded in industries. Conversely, Duong (2023) found that mobile cellular subscriptions, fixed broadband subscriptions, and the number of Internet

users positively influence economic growth while fixed telephone subscriptions have a detrimental effect on it.

Aziz *et al.* (2023) conducted a study exploring the impact of ICT progress on economic growth by creating an ICT diffusion index and examining its effects alongside financial development in 10 developing Asian economies. Using the autoregressive distributed lag (ARDL) model, the findings indicated that ICT negatively impacts economic growth. In contrast, Shodiev *et al.* (2021) revealed through econometric analysis, a positive and significant effect of ICT on GDP per capita shows that a 1% increase in ICT, specifically in fixed broadband subscriptions and Internet usage, contributes to a 0.1669% and 0.2218% increase in GDP per capita, respectively. Consequently, Nguyen and Doytch (2022), employing a two-step system Generalised Method of Moments (GMM) to address potential endogeneity found that ICT patents have a unidirectional causal impact on overall economic growth and significantly contribute to long-term economic growth. Similarly, Appiah-Otoo and Song (2021) using a panel of 123 countries from 2002 to 2017 and constructing an ICT index from mobile, Internet, and fixed broadband data discovered that ICT generally enhances economic growth in both high-income and low- to middle-income countries.

Trade Openness and Gross Domestic Product (GDP)

Trade openness refers to the outward or inward orientation of a nation's economy, where "outward orientation" describes economies that make significant use of opportunities to engage in trade with economies in other regions while "inward orientation" characterises economies that either refrain from or are unable to capitalise on trading opportunities (United Nations, 2020). Fauzel (2022) anticipated that a positive correlation exists between economic growth and trade, suggesting that increased investment in countries would improve trading activities. This

conclusion was drawn using a dynamic vector error correction model applied to the Common Market for Eastern and Southern Africa from 1990 to 2017.

Myovella *et al.* (2019) conducted a study using a GMM estimator with an 11-year dataset from the Sub-Saharan Africa and OECD countries. The results showed that the trade openness variable significantly affected both groups while Ordinary Least Squares (OLS) and fixed effect models showed a negative effect for Sub-Saharan Africa. However, Joo *et al.* (2022) discovered that TO, inflation, and human capital had no substantial impact on growth independently. Interestingly, these host country characteristics significantly influenced the economic growth of Brazil, Russia, India, China, and South Africa when interacting with foreign direct investment inflows, using the generalised least square method from 1987 to 2019 in BRICS economies.

Duong (2023), in his study employing a growth model with panel analysis and estimation methods, discovered that trade openness significantly influences economic growth. Fatima *et al.* (2020) using the system GMM estimator for dynamic panel data models found an indirect relationship between trade openness and GDP growth, specifically noting that trade openness can negatively impact GDP growth in countries with low human capital accumulation. Similarly, Koutima-Banzouzi (2023) employing the ARDL model and annual data from 1979 to 2019, indicated that trade openness positively affects economic growth in Congo. Nam and Ryu (2024) reported that while lower trade barriers, indicative of high trade openness can negatively affect GDP in developing economies, higher trade volumes tend to positively influence GDP. This suggests that excessive trade openness may hinder economic growth, whereas increased trade volumes can be beneficial. Furthermore, Nam *et al.* (2023) compared the effects of trade openness on GDP growth in ASEAN member states and found that trade openness positively impacts GDP growth.

Inflation and Gross Domestic Product (GDP)

Inflation refers to an ongoing rise in the average price level of all goods and services within an economy, which negatively affects societal welfare and future economic development (Fernando *et al.*, 2023). Gupta and Bhatia (2021) stated that the rate of inflation plays an important role in defining the long-term economic impacts on a country regarding price stability. Moreover, inflation and government spending are key factors contributing to a country's development. Mouna *et al.* (2020) conducted a GMM study involving 149 countries from 2012 to 2016, finding no statistically significant relationship between inflation and economic growth in high-income, low-income, or upper-middle-income countries. However, a negative and statistically significant relationship was observed in lower-middle-income countries. Rakshit (2021) employed an ARDL model in India from 1979 to 2017, corroborating the findings that inflation negatively influences growth before and after the implementation of reforms. Another ARDL study by Thaddeus *et al.* (2021) supported these results, concluding that a 1% increase in inflation results in a 1.5% decline in economic growth, thereby confirming theoretical predictions.

Bhawmick *et al.* (2023) using the ARDL bounds test found that inflation negatively affects GDP growth over time with consistent relationships between the variables demonstrated by F-statistics. In contrast, Ramallari and Merko (2023) observed that inflation had a positive impact on GDP. Xiong (2023) concluded that there is no linear relationship between inflation and GDP, suggesting that inflation can have positive, negative, or neutral effects on economic growth. Mbon Issie (2023) found a complex dynamic: A 10% rise in consumer price inflation leads to a 10% decline in GDP growth while a 1% increase in GDP deflator inflation results in a 0.11% decrease in GDP, alongside a significant link between inflation and economic growth in the region.

Unemployment and Gross Domestic Product (GDP)

Unemployment refers to individuals within the labour force who are available and willing to work but unable to find employment. A high unemployment rate indicates economic distress while a low rate suggests an overheating economy (Hayes *et al.*, 2022). According to Aly (2020), the effects of unemployment are not fully understood and depend on various factors, including the degree of development, rate of persistent unemployment, population size, and human and physical capital. Minviel and Bouheni (2022) agreed that unemployment also includes individuals who have arranged future employment but are not actively seeking work. There was also an inverse relationship between unemployment rates and economic growth, as evidenced by a sample of 101 countries from 2000 to 2020. In contrast, Soylu *et al.* (2018) found a positive relationship between unemployment and economic growth in Eastern European countries. However, Jafrin *et al.* (2021) using the pooled OLS method with data from 1990 to 2017 across five South Asian Association for Regional Cooperation countries revealed that unemployment had an insignificant impact on economic growth.

Zhong (2024) examined the relationship between real GDP growth rates and unemployment rates, noting their typically negative correlation. Using data from 1948 to 2023, the study employed linear and non-linear regression techniques, along with autoregressive integrated moving average modelling to analyse this relationship and predict future trends. The results showed that non-linear regression better captures the relationship between GDP growth and changes in the unemployment rate. Similarly, Wang (2023) in an analysis of recent recession periods using the Granger causality test found that the unemployment rate drove changes in real GDP and negatively impacted it. Januri *et al.* (2022) applying a cointegration test

on quarterly data from 2010 to 2020 found that unemployment and GDP were stationary at first differencing and had long-term relationships. The findings suggested that both long-term and short-term unemployment rates significantly influenced GDP.

Methodology

This section outlines the regression model used to investigate the influence of digitalisation and macroeconomic factors on the economic growth of seven ASEAN countries. The relationship between the independent variables—ICT, unemployment (UNEM), inflation (IF), and trade openness (TO)—and the dependent variable, GDP was examined using a static panel regression analysis. The model was adapted from Habibi and Zabardast (2020) and Kurniawati (2022).

Sample of the Study

The sample data focused on seven ASEAN countries: Brunei Darussalam, Cambodia, Indonesia, Malaysia, the Philippines, Singapore, and Thailand covering a 20-year time frame. Due to the lack of complete and accessible data, three ASEAN countries—Lao PDR, Myanmar, and Vietnam—were excluded. The variables used were GDP (current US Dollars), ICT (mobile cellular subscription per 100 people), inflation (consumer price, annual %), trade (% of GDP), and total unemployment (% of total labour force, modelled ILO estimate). All data were sourced from the World Bank database for the period 2002 to 2021.

Theoretical Model

The empirical model for this study conceptualises the relationship between the dependent and independent variables. A static panel data regression was employed to investigate the effects of digitalisation and macroeconomic factors such as inflation, trade openness, and unemployment on the economic growth in the selected ASEAN countries. The study adapted and followed the econometric models developed

by Habibi and Zabardast (2020) and Kurniawati (2022). The regression model was constructed as follows to analyse the relationships:

$$GDP_i = \beta_0 + \beta_1 ICT_{it} + \beta_2 TO_{it} + \beta_3 IF_{it} + \beta_4 UNEM_{it} + e_{it} \quad (1)$$

where GDP_{it} is the gross domestic product, representing economic growth for country i in year t . ICT_{it} represents the digitalisation factor, measured by mobile cellular subscriptions per 100 people. The three macroeconomic factors in this model are TO_{it} , which represents trade openness, measured by trade as a percentage of GDP; IF_{it} representing annual consumer price inflation (%); and $UNEM_{it}$ representing total unemployment (% of total labour force, modelled ILO estimate). e_{it} represents the error term in the model.

This study aimed to investigate the relationship between digitalisation and macroeconomic factors and their impact on the economic growth of seven ASEAN countries, and examine whether the findings align with endogenous growth theory and prior research.

Data Analysis

This study employed static panel data analysis to examine the relationship between digitalisation and economic growth, and macroeconomic factors and economic growth in ASEAN countries, utilising a dataset comprising seven cross-sectional units ($N = 7$) and a time period of 20 years ($T = 20$), resulting in a total of 140 observations. The choice of static panel data regression was based on its ability to yield more accurate results given the number of cross-sectional units and time periods (Sohag *et al.*, 2018). The dynamic panel data model, GMM was deemed unsuitable for this study due to the fact that the main interest of this study lies in understanding the impact of variations within entities (such as changes within countries, firms, and individual over time) rather than across them. The static model can effectively isolate and measure these effects by controlling for any unobserved heterogeneity through entity-specific effects (Baltagi, 2012).

The following tests were performed: Descriptive statistics and the Jarque-Bera normality test, which provided insights into the data. Subsequently, panel specification tests identified the appropriate panel data analysis method, selecting among the Pooled Ordinary Least Squares (POLS) model, Fixed-Effect (FE) model, or Random-Effect (RE) model. To establish a robust panel regression model, diagnostic tests were used identify potential issues such as multicollinearity, serial correlation, and homoscedasticity.

Descriptive Statistical Analysis

Table 2 presents the descriptive statistics for the dependent and independent variables while Table 3 displays the results of the Jarque-Bera normality test for each variable included in the study.

Table 2 summarises the descriptive statistics for each variable in the model. The skewness values indicated that none of the variables equalled 0, which is necessary for a normal distribution (Gujarati & Porter, 2009). Specifically, GDP and ICT exhibited a negative skewness with tails skewed to the left while the variables IF, UNEM, and TO showed a

positive skewness with tails skewed to the right. Regarding kurtosis, the value should be three for a normal distribution (Gujarati & Porter, 2009). In this study, no variable had a kurtosis of three; ICT, IF, and TO had kurtosis values greater than three, indicating a leptokurtic distribution. Conversely, GDP and UNEM had kurtosis values lower than three, indicating a platykurtic distribution.

Table 3 presents the results of the Jarque-Bera normality test, which was applied to check the normality of the dataset for each variable. The results indicated that all variables were normally distributed as the chi-square values for each variable were above the 0.05 significance level. Consequently, the null hypothesis was not rejected for all variables in the dataset.

Panel Specification Tests

This section discusses the results from three statistical tests conduct to determine the most suitable model for the empirical methodology of this study: The POLS model, FE model, or RE model. First, the F-test was employed to choose between the POLS and FE models. Next, the Breusch-Pagan Lagrange Multiplier (BP-LM) test was applied to determine whether the POLS

Table 2: Descriptive statistics

	GDP	IF	UNEM	TO	ICT
Mean	25.510	2.842	3.611	141.971	4.424
Median	26.145	2.295	3.595	120.135	4.730
Maximum	27.802	24.1	9.32	437.33	5.203
Minimum	22.178	-2.31	0.14	32.98	1.109
Std. Dev.	1.557	3.185	2.277	99.286	0.70
Variance	2.426	10.141	5.183	9857.669	0.640
Skewness	-0.663	2.714	0.326	1.558	-2.104
Kurtosis	2.067	16.650	2.305	4.423	7.389
Observations	140	140	140	140	140

Table 3: Jarque-Bera normality test

	GDP	IF	UNEM	TO	ICT
Chi-square	4.70	5.00	0.07	1.40	1.50
Result	Normal	Normal	Normal	Normal	Normal

or RE model was more appropriate. Finally, the Hausman test was used to compared the FE and RE models.

Table 4 presents the results of these three tests. All tests reported a *p*-value of 0.0000, which is less than 0.01, indicating significant results. Consequently, the null hypothesis for all tests was rejected from the outcomes of the F-test and Hausman test suggested the adoption of the FE model, which was deemed the most suitable for this study (Park, 2011).

Diagnostic Tests

To identify potential issues within the dataset used in this study such as the multicollinearity, homoscedasticity, and serial correlation, diagnostics tests were conducted.

Based on the multicollinearity test using the variance inflation factor (VIF) as shown in Table 5, the results indicates that every independent variable had VIF values of below 10 with a mean VIF of 1.10. According to Gujarati (2003) and O’Brien (2007), a VIF value under 10 signifies no severe multicollinearity. Therefore, these variables were not highly correlated with each other in the model.

The results from Table 6 reveal that both homoscedasticity and serial correlation tests returned the *p*-value of 0.000, which are less than 0.01, indicating significant results. Thus, the null hypotheses for both tests were rejected, confirming serious issues with homoscedasticity and serial correlation in the model. To address these problems, the model could be improved by applying FE (within) regression with a cluster option (Hoechle, 2007), thereby enhancing the robustness of the panel regression analysis.

Panel Data Findings

To identify the effects of digitalisation and macroeconomic factors such as trade, inflation, and unemployment on the economic growth of seven ASEAN countries, a static panel data regression was estimated.

Table 7 shows the regression results using the FE model (within) regression with cluster option estimation which addressed issues such as serial correlation and homoscedasticity in the model. The adjusted R² value of 0.858 reveals that the independent variables—IF, UNEM, TO, and ICT—account for 85.8% of the variation in the dependent variable (GDP) with the remaining 14.2% attributable to factors excluded from this

Table 4: Panel specification tests results

Tests	<i>P</i> -value	Null Hypothesis
F-test	0.000	Reject
BP-LM test	0.000	Reject
Hausman test	0.000	Reject

Table 5: Multicollinearity test (variance inflation factor)

	IF	UNEM	TO	ICT	Mean VIF
VIF	1.18	1.17	1.06	1.00	1.10

Table 6: Homoscedasticity and serial correlation test results

Tests	<i>P</i> -value	Result
Homoscedasticity	0.000	Problem existed
Serial correlation	0.000	Problem existed

Table 7: Regression results of the fixed-effect model

	Fixed-effect Model
Constant term	24.568 (0.00)
TO	-0.006*** (0.000)
UNEM	-0.106* (0.090)
ICT	0.487*** (0.001)
IF	0.011 (0.254)
R ²	0.862
Adj. R ²	0.858
F-statistics	0.000
Total observations	140

Note: (***), (**), and (*) indicated significant at 1%, 5%, and 10%, respectively.

study. Furthermore, the p -value of the F-statistic stands at 0.000 confirming that the independent variables significantly affect the dependent variable at a 1% level of significance, suggesting that this model fits well.

From Table 7, digitalisation (ICT) had a positive and significant impact on economic growth in the ASEAN countries. This result aligns with previous studies (Makun & Devi, 2019; Kurniawati, 2020; Zhang, 2021; Kurniawati, 2022) confirming a positive significant effect of digitalisation on economic growth in the region.

Simultaneously, the TO and UNEM variables demonstrated a significant negative impact on economic growth in ASEAN countries at the 10% level. This aligns with previous studies conducted by Myovella *et al.* (2019), Habibi and Zabardast (2020), Panigrahi *et al.* (2020), Danova and Vozarova (2020), Nayak and Sahoo (2021), Singh and Siddiqui (2021), and Minviel and Bouheni (2022). Thus, rising unemployment rates and unchecked trade liberalisation significantly hinder economic growth in these countries.

Inflation was the only independent variable in Table 7 that exhibited insignificant relationship with economic growth, as the empirical result yielded a p -value of 0.254, exceeding the 0.1 significance level. This finding is consistent with previous studies (Rahman *et al.*, 2019; Mouna *et al.*, 2020; Pekarcikova *et al.*, 2022) confirming that inflation did not significantly influence economic growth in the seven ASEAN countries.

Conclusions and Recommendations

This study achieved its objectives of investigating the effects of digitalisation and macroeconomic factors on the economic growth of seven ASEAN countries from 2002 to 2021. The regression results revealed three significant variables affecting economic growth in ASEAN: ICT, trade openness, and unemployment. These findings support the capitalisation effect within the framework of endogenous growth theory. According to Aghion and Howitt (1997), advancements in technology can lead to a negative correlation between unemployment and economic growth. Furthermore, the theory

posited that human capital, innovation, and knowledge are critical factors influencing growth, as countries with low human capital accumulation typically experience a negative relationship between trade openness and economic growth (Mengesha & Singh, 2023).

The regression analysis indicated a positive and significant relationship between ICT and economic growth in ASEAN countries. This finding underscores the importance of ICT development for economic progress in the region. Governments should prioritise upgrading broadband networks and data centres to support the digital economy. Additionally, promoting technology adoption is essential; increasing ICT utilisation among businesses and individuals can boost productivity and stimulate economic growth. Furthermore, governments should increase funding for R&D and offer tax incentives for technology startups to foster innovation and skill development. To prepare workers for success in the digital economy, it is crucial to allocate funds for digital skills training.

The regression analysis also revealed a significant negative relationship between unemployment and economic growth in ASEAN countries. This study suggests that governments should focus on reducing unemployment to enhance economic growth. To create more jobs, governments can increase public works programmes, offer business tax incentives, and support entrepreneurship. Additionally, improving labour market policies such as by raising the minimum wage, enhancing unemployment insurance, and expanding job training programmes can be effective. Finally, maintaining macroeconomic stability is crucial; governments should aim to keep inflation low and interest rates stable, improve the business environment through favourable tax policies and regulations, and facilitate access to finance to combat unemployment.

Trade openness was the final variable in the regression analysis that negatively impacted economic growth in ASEAN countries. This finding suggests that these governments should

strive for a balance between trade liberalisation and economic development, as well as stability. It is recommended that ASEAN governments review and possibly revise their trade agreements to ensure fair and balanced negotiations, which could boost exports while protecting domestic industries and workers. Additionally, governments should consider tariffs and other trade barriers to safeguard domestic industries and jobs while maintaining trade liberalisation. Support for domestic industries through tax breaks, subsidies, and R&D fundings is essential to enhance their competitiveness in the international market. Finally, ASEAN governments should assist workers and industries in adapting to trade liberalisation by expanding job training programmes and compensating workers displaced by trade liberalisation.

This study contributes to ASEAN countries by providing insights for both society and economists. The governments in ASEAN countries can accelerate the advancement of digital technology, increase employment, maintain macroeconomic stability by keeping inflation low and interest rates stable, improve the business environment through tax policies, regulations, access to finance, and address unemployment.

Future research could expand on this study by incorporating additional macroeconomic variables such as government expenditure and national income, as well as digital and ICT indicators such as broadband penetration and Internet users to gain a deeper understanding of economic growth. Additionally, employing advanced analyses such as dynamic methods like GMM may more effectively address econometric issues such as serial correlation and homoscedasticity than the methods utilised in this study. Finally, as this study focused on only seven ASEAN countries, future researchers should consider including Lao PDR, Myanmar, and Vietnam to further explore the impact of digitalisation on macroeconomic variables and overall ASEAN economic growth.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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